Anatomy and Histology of the Stomach

Introduction

This lesson, the first of three stomach lectures, focuses on the anatomy and histology of the stomach, then touches on the physiology by naming which cells secrete which substance. The interactions of those secretions (the regulation of gastric acid secretion), their intracellular mechanisms, and their pathologic states will be covered in the following two lessons. The stomach is not necessarily such a high-yield organ that it warrants so many lessons. Rather, the system is so well studied and so difficult that the complexities of gastric acid secretion make it a keen target for licensing examinations. And because we understand these complexities so well, it is easy to connect the physiology to pharmacology and disease.

This lesson introduces the stomach, demystifies the vasculature around the celiac trunk (information you'll use in all the stomach lessons and a few that follow), and details some of the cells in the stomach and what they do. You will see how surgeons and endoscopists divide the stomach (anatomist's perspective) and how histologists divide the stomach (histologist's perspective). This is also your introduction to the fundic glands. Unlike the ducts and acini of the exocrine glands, the word gland, in reference to the gut tube, means simple columnar epithelium that invaginates into its lamina propria (also called a crypt in the intestines). Finally, we conclude with the physiologist's perspective of the stomach, how the stomach contributes to mechanical and chemical digestion.

The food bolus from swallowing becomes chyme once it hits the stomach. Throughout this lesson, we use chyme and food bolus interchangeably to get you used to thinking of them as the same thing.

This note set is so long, not because there is so much information in it, but because accurately communicating that information requires a lot of pitfall-dodging. And telling you what things aren't becomes more important than telling you what they are.

Global Anatomy

The stomach is derived from the foregut. It is made from endoderm, as all gut organs are. It is connected to the esophagus proximally and the duodenum distally. It sits on the left side of the abdomen, in front of the lesser sac. Through embryogenesis, the hollow foregut becomes the stomach with a little twist, positioning itself to the left of the midline and creating the lesser sac behind it (see GI: Hepatobiliary #1: *Liver Anatomy and Physiology* for more details).

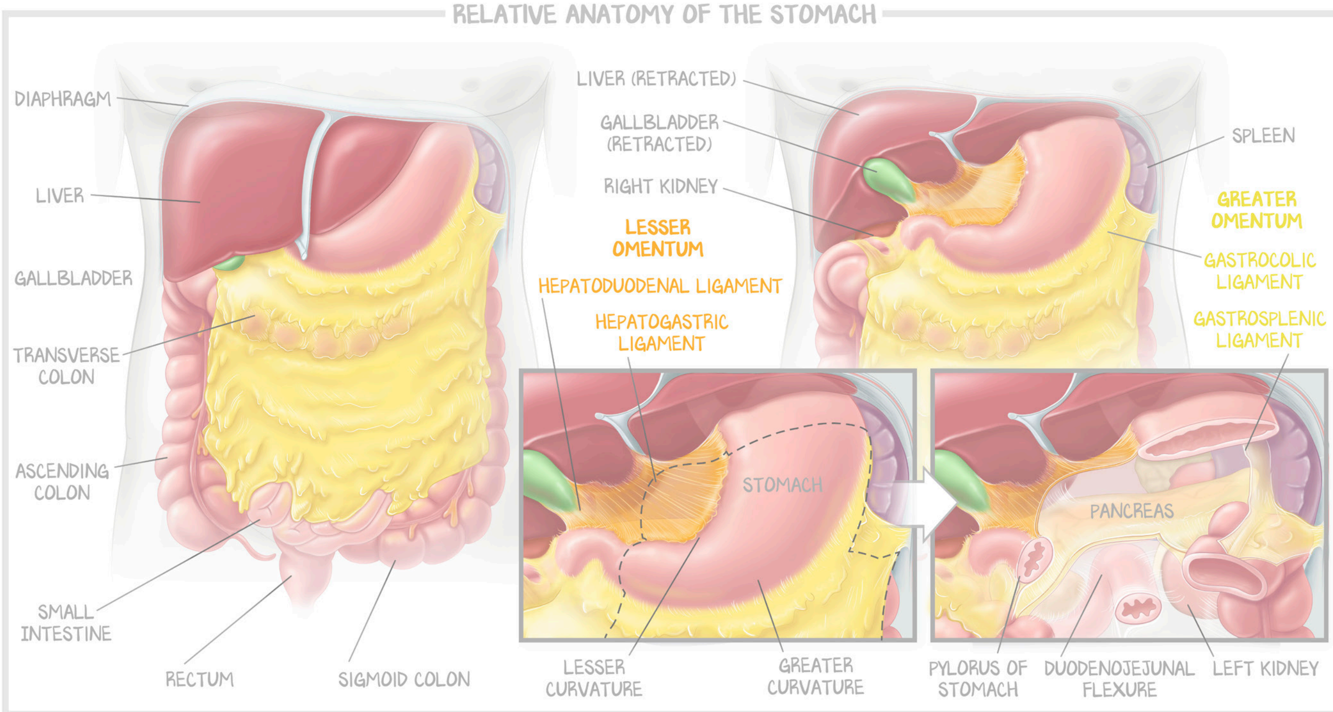

Figure 4.1: Relative Anatomy of the Stomach
Seeing it in words makes it sound hard. Hopefully, seeing it illustrated makes it not so bad. The stomach is a curved bag in front of the abdomen and under the rib cage. The lesser curvature is connected to the other organs behind it by the lesser omentum. The greater curvature is connected to the organs below it by the greater omentum. The mesothelium of the peritoneal cavity is called serosa over the stomach, where it contains blood vessels, lymphatics, and nerves, and where the two layers of mesothelium come close together, it is called omentum. Mesentery, ligament, and omentum all describe the same thing—the lining of the peritoneal cavity enveloping what grew into it. More on this in Abdominal Wall 3. Here, stay focused on gross anatomy and the big picture.

The stomach has an inner curvature on the right called the **lesser curvature**—the one closer to the liver and gallbladder—and an outer curvature on the left called the **greater curvature**. The lesser curvature has attached to it the **lesser omentum**, connecting the liver to the stomach (aka the hepatogastric ligament) and the liver to the duodenum (hepatoduodenal ligament). The **greater omentum**, which comes off the greater curvature, connects the stomach to the spleen (gastrosplenic ligament) and the stomach to the colon (gastrocolic ligament). "Connected to" hasn't been rigidly defined yet in the course. Don't go further than we have taken you in this lesson. Do not try to mentally fill in the other organs and their detail. Isolate the stomach. We'll add on other organs, define what omentum, ligaments, and mesentery are, and cover the embryogenesis of the peritoneal cavity as we progress through the module.

Vasculature of the Stomach

Remember this in anatomy class? It was SO hard. But it isn't hard. We struggled the first time through it, too. We struggled through it the second time. There are so many named arteries that crowd this area of the body, and their names are so long, that learners tend to give up before they even get started. But because they are named after organs, it's actually really easy if you're shown an easier way. There is **<u>ONE</u> celiac trunk**. A boatload of arteries is going to come off this celiac trunk. Instead of all being branches of the trunk itself, they are branches of branches of branches. And that's what made this "hard." **Only** the **celiac trunk** perfuses the stomach. Many branches perfuse the stomach, but they all come from the same one celiac trunk. There are real implications for surgery to know where those arteries are and to what they anastomose. Performing a subtotal gastrectomy or placing a gastric sleeve means knowing where the blood vessels are, where they go, and whether there is an alternative blood supply through an anastomosis. A full ligation of one artery can be safely performed if there is an intact anastomosis. The intact stomach has a redundant blood supply, except at the fundus. Read the next four paragraphs without referencing Figure 4.2, then read it again after looking at Figure 4.2.

The celiac trunk comes off the aorta. These directions are in relation to the patient, not to you looking at the patient. So you can do this on yourself. Your stomach is on your left, in front. The aorta is on the left side, in back. The celiac trunk pops straight out of the aorta heading towards the stomach. One branch of the celiac trunk goes up and to the left. That branch is the **left gastric artery**. The left gastric comes immediately off the celiac trunk, goes up and to the left to the top of the lesser curvature, then runs down the length of the lesser curvature. It supplies the superior **lesser curvature** of the stomach. If we follow it around the lesser curvature of the stomach, that same artery is named the **right gastric artery** at the inferior end of the lesser curvature. So, both the left and right gastric arteries feed the lesser curvature of the stomach. And being on the same side of the stomach, they form an anastomosis. Anastomosis? If you keep following that right gastric artery, it finds its way into a tangle of a mess of arteries. If you follow the source of that tangle back to its origin, what do you find? The celiac trunk. More on the tangle at the end. *Celiac trunk back to celiac trunk. Right gastric to left gastric artery. Lesser curvature. An anastomosis.*

The celiac trunk comes off the aorta. One branch of the celiac trunk goes straight and left. That branch is the **splenic artery**. It will feed the spleen and pancreas. It reaches behind the stomach, stretching out towards the spleen. Near to its arrival at the spleen, two arteries branch off from the splenic artery, both branches for the stomach. One of those stomach arteries goes up and is named the short gastric arteries (there are many of them but learn it as one **short gastric artery**). It goes to the **fundus**. The only blood supply to the fundus, without anastomosis, is the short gastric arteries. The other of those stomach arteries is the **left gastroepiploic artery**. Epiploic is synonymous with omental. Which curvature is the spleen near? The greater curvature of the stomach. What else is near the greater curvature of the stomach? The greater omentum. So, the "correct name" for this artery is the left gastro-omental artery (no one calls it that, but that's what it is). Follow it down and around the greater curvature of the stomach, and it becomes the right gastro-omental artery (**right gastroepiploic artery**). So, both the left and right omental arteries feed the greater curvature of the stomach. And being on the same side of the stomach, they form an anastomosis. Anastomosis? This sounds familiar . . . If you keep following that right gastro-omental artery, it finds its way into a tangle of a mess of arteries. The same tangle that the gastric arteries found. Trace it back to its source, and you find the celiac trunk. *Celiac trunk to celiac trunk. Right gastro-omental to left gastro-omental artery. Greater curvature. An anastomosis.*

You have already completely irrigated the stomach. The right and left gastric arteries handle the lesser curvature. The right and left gastroepiploic arteries handle the greater curvature. The short gastric artery does the fundus. Now just to find your way through that tangle.

The celiac trunk comes off the aorta. One branch goes to the right. It is named the common hepatic artery. It's common, all right, but it ain't no hepatic only (it is the worst-named artery). Let us refer to this as the **CommonAndHepatic artery** instead. The CommonAndHepatic artery will give off two branches and then disappear up into the liver as the **proper hepatic artery**. The second branch is the easiest. On its way to the liver, the CommonAndHepatic Artery gives off a branch that heads for the inferior end of the lesser curvature of the stomach. Tada! The right gastric artery! The first branch of the CommonAndHepatic artery is more complex. The first branch of the CommonAndHepatic artery is the gastroduodenal artery, which will supply the stomach (gastro) and duodenum (duodenal). Immediately after this artery branches, it splits into two arteries. One branch of the gastroduodenal artery takes a left and heads to the front of the stomach, towards the inferior end of the greater curvature. Tada! The right gastroepiploic artery. The gastroduodenal artery, having lost its gastro part (and also being terribly named), changes its name to the superior pancreatoduodenal artery, which will irrigate some of the pancreas and the first part of the duodenum. *The common hepatic first off-branches the gastroduodenal (which becomes the right gastroepiploic), then off-branches the right gastric, and what is left behind is the proper hepatic artery, which goes and does liver and gallbladder stuff that we haven't engaged yet.*

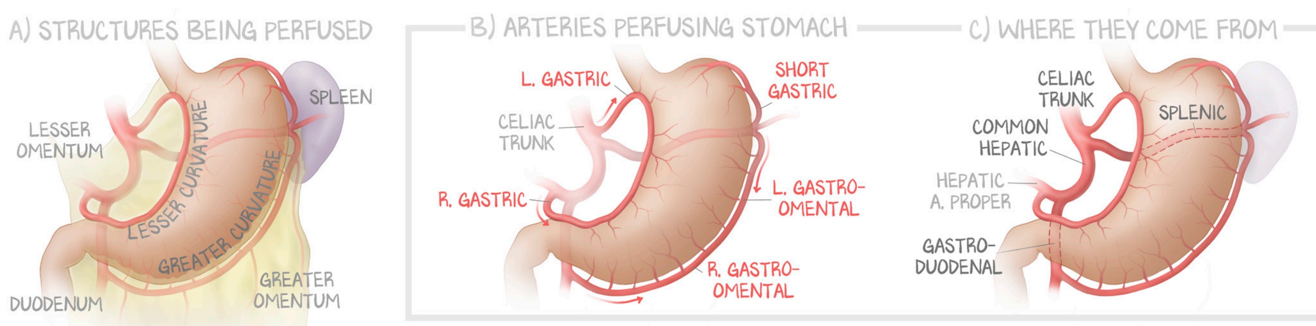

Figure 4.2: Vasculature of the Stomach
(a) Orientation of the key organs whose names show up in the branches of the arteries that perfuse the stomach. (b) Highlighting the arteries of the stomach: left and right gastric, lesser curvature; left and right gastro-omental (gastroepiploic) arteries, greater curvature; short gastric, fundus. (c) Highlighting where those arteries come from: the splenic artery brings the short gastric and the left gastro-omental. The left gastric is its own branch of the celiac trunk. The tangle—where the right-sided arteries come from—is a hassle. The right gastro-omental comes from the gastroduodenal, which comes from the common hepatic artery. The right gastric also comes from the common hepatic artery.

FEEDS	ARTERY	FROM
Fundus	Short gastric arteries	Celiac trunk, splenic artery, short gastric
Greater curvature	Left gastroepiploic	Celiac trunk, splenic artery, left gastroepiploic
	Right gastroepiploic	Celiac trunk, common hepatic, gastroduodenal, right gastroepiploic
Lesser curvature	Right gastric	Celiac trunk, common hepatic, right gastric
	Left gastric	Celiac trunk, left gastric

Table 4.1: Simplified Gastric Arteries
The table is separated by the general location of irrigation—fundus, greater curvature, and lesser curvature.

Anatomy of the Stomach: Anatomic Regions

Anatomists divide the stomach into four parts: cardia, fundus, body, and antrum. Histologists divide the stomach into three parts based on the structure and function of the glands. We'll do the anatomists' version first, then spend a lot of time on the histologists' view. Together, they inform the physiologists' view.

Anatomists say: The cardiac stomach is the stomach immediately below the lower esophageal sphincter. An imaginary line is drawn from the top of the esophageal opening across the stomach laterally. Above that line is the fundus. Below that line is the body. The antrum is the part of the stomach at its distal end. It is narrowed and approaches the pylorus. To separate the anatomists' part from the histologists' region, we are going to add a suffix in both cases—"part" for anatomist's, "region" for histologist's. This is an arbitrary and artificial designation to help the learner keep them straight.

The **cardia** (cardia part) is the "in" hole, the site where the esophagus enters the stomach, the GE junction. Here, there are mucus-secreting cells that protect the epithelium of the esophagus from the acidic contents of the stomach. The transition from the esophagus (which cannot tolerate stomach acid) to the stomach (which produces stomach acid) happens with a little buffer (stomach epithelium that doesn't secrete acid). It appears the same as the rest of the stomach on gross anatomy.

The **antrum** (antrum part) is the "out" hole. The antrum ends with the **pyloric sphincter**. The pyloric sphincter (like all sphincters) remains tonically contracted until induced to relax. The antrum doesn't secrete acid, much like the cardia. But the antrum will perform powerful contractions that aid both in the mechanical digestion of chyme and the expulsion of gastric contents into the duodenum through the pyloric sphincter. The pylorus prevents chyme from entering the duodenum until the body and antrum have sufficiently liquefied the food bolus.

The **fundus** (fundus part) sits superior to the rest of the stomach. It is used for storage via receptive relaxation. This is what causes the gastric bubble on X-rays—air rises. The fundus is above the entrance of the esophagus and so can store undigested food. It is also the spot where ulcers may go missed on endoscopy (the operator neglecting to turn the camera around and look up).

The **body** (body part) is the majority of the stomach. The body and the fundus are continuous and serve the same function—production of acid. Folds of the lining of the stomach called **rugae** enable the stomach to stretch in response to a meal. As gravity pulls food down, the body is generally what stirs the contents (churning) and also generates the rhythmic activity that will generate the peristaltic movements of the stomach, driving stomach contents into the antrum.

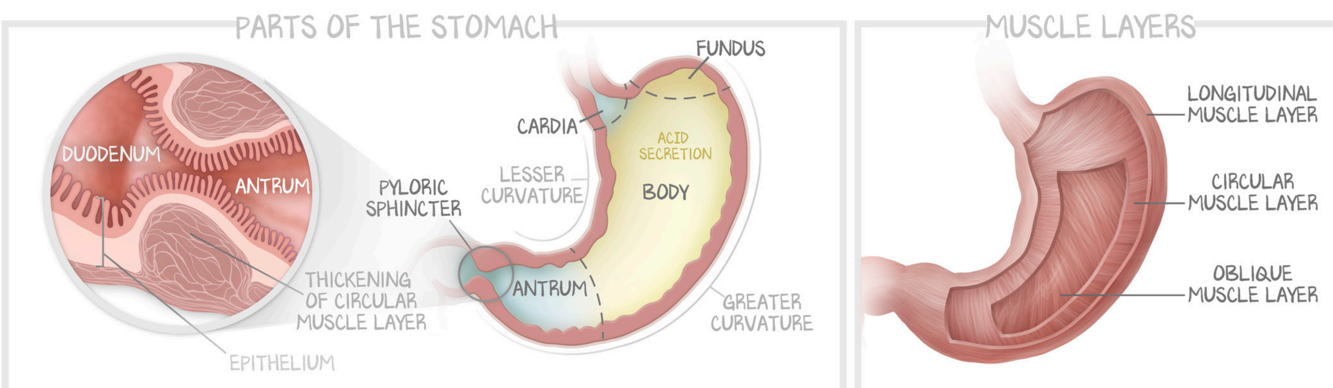

Figure 4.3: Parts of the Stomach
Anatomists and histologists agree that the antrum and cardia are distinct regions. Anatomists divide the histologic fundus region (everything in yellow, which makes acid) into the fundus and body (also sometimes called corpus) parts. The pylorus is a sphincter and is tonically contracted. The muscularis externa adds an oblique muscle layer.

Histologists View of the Stomach: Histologic Regions Based on Glands

Histologists see things a little differently. Essentially, they don't see a difference between the fundus and the body. That is because histologists just see mucosa under a microscope. We will define glands after this discussion on the histologists' regions. For now, "gland" is just a thing. In a few pages, it will be clearly defined. Histologists see three regions based on glands—cardia, antrum, and fundus.

Cardiac glands are found at the opening of the lower esophageal sphincter, called the **cardiac region**. These glands secrete mucus and bicarbonate. This region serves to protect the esophageal epithelium from the acidity of the stomach contents.

Antral glands are found at the opening of the pyloric sphincter, the **antral region**. Like cardiac glands, they produce mucus and bicarbonate. They are not identical in appearance or secretion to cardiac glands, but they serve the same purpose—secrete mucus and not acid to protect the gut tube on the other side of the sphincter from stomach acid.

Fundic glands are found everywhere else, the **fundic region**. The fundus region (histologists) comprises both the fundus and body parts (anatomists) and has fundic glands, which are the gastric glands of the fundus region. Thanks, medical science. Recognize that some texts and speakers will even use "gastric gland" to mean only the fundic glands. To avoid confusion, we will use "fundic glands" to refer to the gastric glands specific to the fundus region.

Glands of the Stomach

The stomach is part of the gut tube, so it has the same layers as the esophagus: mucosa (with the epithelium, lamina propria, and muscularis mucosae), submucosa (with vessels, nerves, and glands), a muscularis externa (with longitudinal and circular muscles), and a serosa (adventitia lined with the mesothelium of the peritoneal cavity, separating the stomach from other organs). But two key differences distinguish the stomach from the esophagus. The first is the addition of an **oblique muscle** to the muscularis externa. This facilitates the churning of gastric contents (more on this later). The second is the **invagination of the epithelium** to form pits and glands.

The stomach's epithelium is a simple columnar epithelium. That epithelium invaginates into the lamina propria over and over again across the entirety of the stomach. This means there will be tall lamina propria papillae and deep invaginations of the epithelium to match. The terminology can get confusing, and different texts can use different words to mean the same thing, so we're going to establish three discrete histologic zones present in each invagination. "Histologic zone" is a term we created to differentiate them from the anatomists' parts and the histologists' regions. These zones are based on how far down in the invagination they are and are named the surface, gastric pits, and gastric glands. The **surface** is anywhere the epithelium is not invaginated. The surface is closest to the gastric contents—acid and chyme—and is protected from the acid and mechanical injury of digesting food by a layer of mucus (more on this in a bit). Then there are invaginations of the epithelium into the lamina propria. All invaginations are at least a **gastric pit**—the same type of cells as the surface, but these are lining the invagination. Sometimes the bottoms of those pits open into a **gastric gland**.

The epithelium of the stomach is always a simple columnar. The columnar cells that line the **surface** are **mucous cells**. The columnar cells that line the **gastric pits** are the same **mucous cells**. The columnar cells that line gastric glands are highly variable and are the subject of the next section. This section is to get you to visualize what glands are. They aren't glands like the parotid gland (an organ); they are invaginations of the epithelium into the lamina propria. We didn't name them glands, but being called glands makes reading about them for the first time confusing.

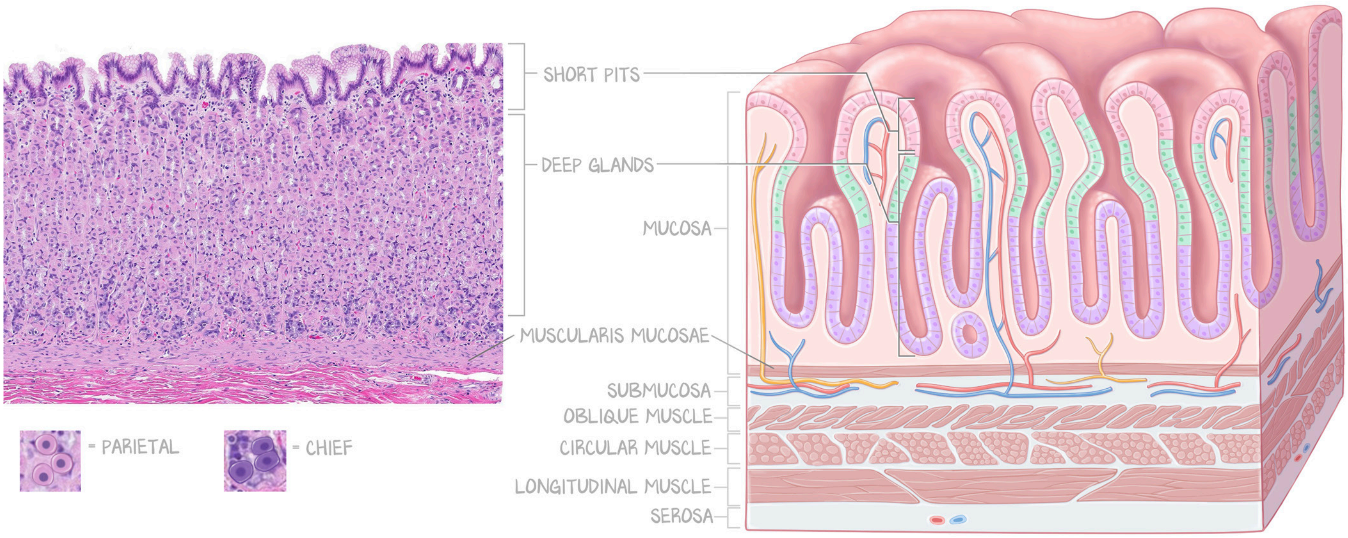

Figure 4.4: General Histology of the Stomach
The gastric pit is an invagination of the surface epithelium into the lamina propria, creating a lumen into which mucous cells secrete mucus. Gastric glands are a continuation of that invagination, sharing the basement membrane and lumen of the gastric pits. Glands secrete various compounds into the lumen, which are then flushed upward into the stomach lumen. The histology sample demonstrates a normal stomach. This slide has short gastric pits and obvious columnar mucosal cells on the surface epithelium but less obvious tubular structures that are the glands. The illustration exaggerates for your comprehension. The histology slide demonstrates what it actually looks like. The pink, puffy cells are parietal cells. The darkly staining cells at the base of the mucosa are chief cells.

Cells of Fundic Glands

The mucosal cells of the surface epithelium secrete **mucus** and **bicarbonate**. The mucus creates a mucin-like gel that separates the epithelium from the gastric contents. Bicarbonate is alkaline and serves to neutralize stomach acid. The bicarbonate is not allowed into the stomach lumen, but rather is kept beneath the mucin-like gel, ensuring that any acid that gets through that gel is neutralized. Mucus and bicarbonate protect the epithelium.

Fundic glands begin with a gastric pit, an invagination of the epithelium lined with mucus- and bicarbonate-secreting mucosal cells, the same as the surface mucosal cells. Before the start of the gland itself, there is a region known as the **isthmus**. The isthmus is where the stem cells of the gland are. These cells divide and differentiate a daughter cell. Those that are destined to be mucosal cells are sent up the pit towards the surface. Those that are destined to be cells of the gland are sent down into the gland.

There is a long **neck** of each gland that is narrow and opens into a wider **fundus**. Why medical science chose to name yet another thing fundus is frustrating, but is what you're stuck with. In the fundus of the fundic gland found in the fundus region of the stomach, the gastric gland branches into two or three segments. Each segment's lumen is contiguous with the lumen of the neck. The cells of the neck and fundus of the fundic gland contribute to **gastric juice**, which consists of hydrochloric acid, pepsin, mucus, and intrinsic factor. There are three cells left to discuss (having covered mucus neck cells and stem cells above): parietal, chief, and enterochromaffin-like cells.

Parietal cells are acid-secreting cells. Parietal cells are found in the greatest abundance in the neck of the fundic glands but can be identified sporadically throughout the entire gland. They have two secretions. The first, **gastric acid** (hydrochloric acid, HCl), is important for the chemical digestion of ingested food and activation of the chief cells' secretion. The second is **intrinsic factor**, a molecule necessary for B_{12} absorption in the terminal ileum.

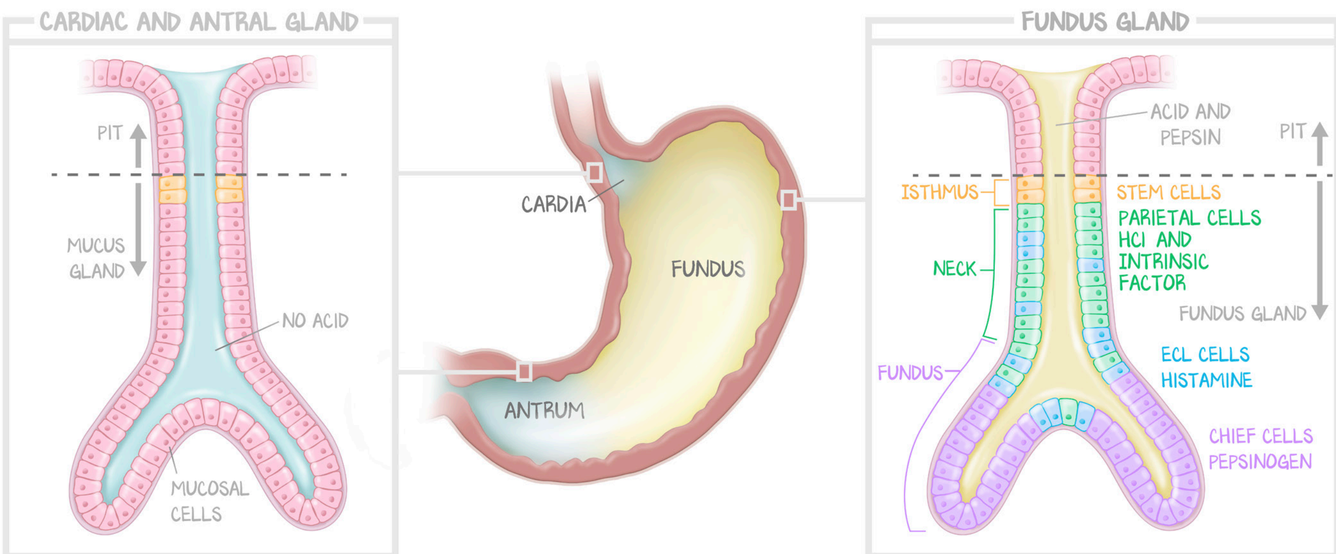

Figure 4.5: Pits and Glands Histology
The histologic view is three regions for three glands. To simplify, because the cardia and antrum share the same function (not acid production) and are really simple, learn them as mucous glands. The fundic glands are complicated, consisting of the mucosal cells that line the gastric pit, the stem cells that serve both the surface and the gland, the parietal and ECL cells in the neck, and the chief cells of the fundus.

Chief cells secrete acid-activated digestive enzymes. Chief cells are located in the base of the gland, deep in the fundus of the fundic glands. They secrete **pepsinogen**, an inactive precursor to the highly proteolytic enzyme **pepsin**. Pepsinogen is activated to pepsin upon contact with acidic gastric juice. These cells also produce **gastric lipase**, which, like salivary lipase, is activated by a low pH.

Enterochromaffin-like (ECL) cells secrete histamine, but not into the lumen of the gland. Instead, they release histamine into the lamina propria, into the blood vessels of the gland. This histamine is, therefore, technically hormonal, but its effects are local, affecting only neighboring parietal cells. Histamine influences parietal cells to increase acid production. Because histamine acts locally—it doesn't reach the systemic circulation but takes effect on nearby parietal cells of the same gland—ECL cells are found in the neck and fundus.

The gland invaginates into the lamina propria. The lamina propria is where the blood vessels are. They travel up (arterial supply) the side of the gland and irrigate the surface mucosal cells, then they travel down (venous drainage). This enables local hormonal regulation (ECL cells secreting histamine) as well as systemic hormonal regulation circulating through the bloodstream (the subject of the next lesson).

Other Cell Types

These are the players of parietal cell regulation. We will get into that regulation in the next lesson. The other cell types found in the epithelium of the gastric mucosa are G cells, D cells, and P cells.

G cells secrete **gastrin**, the make-more-acid signal. They are present in the **antrum** and **duodenum**. The job of these cells is to figure out whether there is food to be digested. To do that, G cells assess the stomach lumen for the presence of fats and triglycerides. They secrete gastrin if they find food. If they don't find food, no more acid needs to be secreted, and they don't make gastrin. Gastrin is secreted into the bloodstream (endocrine signaling).

D cells secrete **somatostatin**, the stop-making-acid signal. Somatostatin sends the GI system into "somatostasis." D cells send the stop signal when food has entered the duodenum. They got the name D cells because they are in the **duodenum** (but oops, they're also in the antrum and pancreas). The activation of D cells reduces acid secretion. D cells sense luminal H+ ions. Gastric acid has a very low pH. The duodenum can only process a little bit of chyme at a time, so when a new bolus with its low pH gets through the pylorus, the D cells give the signal that the duodenum has received its next bolus and tells the parietal cells not to send any more through just yet.

CELL TYPE TO LOCATION IN STOMACH	
Mucous cells	Everywhere
Parietal cells	Fundus
Chief cells	Fundus
ECL cells	Fundus
G cells	Antrum
D cells	Duodenum

LOCATION IN STOMACH TO CELL TYPE	
Cardia	Mucous cells
Fundus	Parietal, chief, ECL, P, mucous
Body	Parietal, chief, ECL, P, mucous
Antrum	G cells, D cells, mucous
Histologically, fundus + body = fundus region	

Table 4.2: Cells of the Stomach and Where They Are

Physiology of Chemical Digestion

Those are the players—the cell types and the regions of the stomach. Now we turn our attention to the function of the stomach.

Parietal cells secrete acid. Chief cells secrete pepsinogen and gastric lipase. The enzymes in the stomach are activated by stomach acid and responsible for digesting whatever the esophagus drops into the stomach. Enzymatic digestion is a significant part of digestion, and one that is mostly managed by the duodenum with help from pancreatic enzymes and bile salts from the gallbladder. Thus, the stomach's main job is to pulverize the food bolus into **chyme** and make it liquid enough for duodenal enzymatic digestion to be effective (what we discuss for the remainder of the notes after this section). But the stomach does start the process of chemical digestion.

Stomach acidity directly contributes to chemical digestion by **denaturing the proteins** in the meal. Stomach acidity **activates pepsinogen** to **pepsin** to begin enzymatic protein breakdown. Stomach acidity **activates lingual lipase** from the mouth, beginning the breakdown of **triglycerides**. Stomach acidity **INactivates salivary amylase**, which is important for **carbohydrate** digestion.

Mechanical Digestion: Gastric Emptying

The stomach does three things to make the food bolus more like chyme. The body of the stomach **churns**, the body of the stomach then **propels**, and the **antrum grinds**.

The body of the stomach **churns**. Churning is achieved with both the circular muscles and the **oblique muscles** of the muscularis externa. The stomach is particularly good at churning. It does this to mix the recently ingested food with the digestive enzymes and to use the vigorous mechanics to break that food apart. The stomach just received a food bolus, so the stomach secreted a bunch of enzymes and acid. Now the stomach turns that food bolus over and over, ensuring that enzyme and acid get all up in that food bolus's business.

The movement of solid particles towards the antrum is accomplished by **propulsion**. There are complicated cells—the interstitial cells of Cajal—we have chosen to remove from our curriculum. They are the pacemakers of the stomach and determine how often peristalsis happens. It is enough for you to know they exist, and it doesn't help you to know how they work. So, we'll continue as if you know what they are. Every so often, about three times per minute as determined by the pacemaker of the stomach, rhythmic **peristaltic contractions** start at the top of the body of the stomach and, in a coordinated fashion, sequentially contract towards the pylorus. The end of that peristaltic contraction is an intense contraction of the pylorus; thus, nothing that was propelled towards the pylorus actually gets through the pylorus. Most of the gastric contents that were propelled in that direction simply smash into the pylorus and are returned to the body for more churning. Being smashed against the wall mixes up the contents and causes mechanical stress on the food bolus. The process of sending it back to the body is called **retropulsion**.

The **antrum contracts, too**. That contraction closest to the antrum **traps chyme in the antrum**. The small bit of gastric content that got trapped in the antrum then undergoes super-churning, called **grinding**. This is the real deal. The most aggressive mechanical pulverizing is happening in the spot immediately adjacent to the pylorus. A small space. A small amount of chyme. Mega churn. Once the chyme is pulverized to particles < 2 mm, a small amount of chyme enters the duodenum. All the while, the stomach has been churning the rest of the gastric content above. When the next pacemaker fires, the process is repeated.

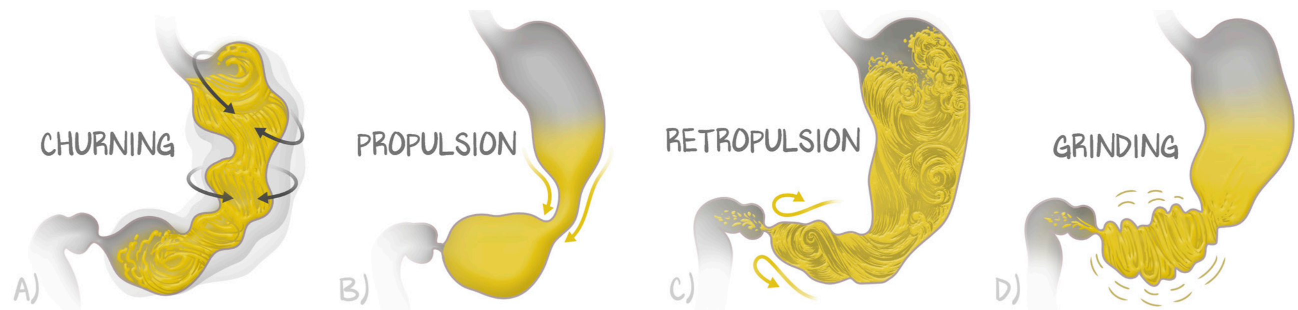

Figure 4.6: Mechanical Digestion in the Stomach
Churning mixes the contents around; propulsion pulverizes the contents against the pylorus and delivers a portion of the contents to the antrum for grinding. The rest is sent back to the body for more churning, a process called retropulsion.

This repeated process of churn, propel, and grind is known as **gastric emptying**. It stops when the stomach is . . . empty. But no, actually not. Only particles < 2 mm can get through the pylorus. Any particles larger than that are eventually emptied during the time between meals by migrating motor complexes.

Migrating Motor Complexes—Mega Peristalsis

The **migrating motor complex** is only seen during the **fasting state**. During a period of fasting, **two hours after a meal**, these mega peristaltic waves **originate in the stomach** and **terminate at the ileocecal valve**. During this time, the pylorus opens and contents greater than 2 mm (the size required to let chyme through the pylorus from the antrum) now CAN be swept through, and anything in the small intestine will be swept through the ileocecal valve into the colon. This is a sort of **housekeeper** that ensures the intestines are sufficiently clean, and that there is nothing left over in the stomach. These complexes are NOT seen during the fasted state, only in the hours after the meal is over. The migrating motor complexes are initiated by **motilin**. Motilin is released from intestinal cells (enterocytes) only when nothing food-related is happening. The default is to release about 100 minutes after gastric emptying is over. If food hits the stomach, the timer gets reset.

Citation

Figure 4.4a: Courtesy of WebPathology.com.

